2-4. Safety Management in Fusion Facilities and Environment

Research and development on the Safety and environment are the major issues for fusion facilities. The variety of issues should be surveyed not only in the field of radiation safety management and radiation protection but also in the field of general safety science, health and environment. Topics of these activities during FY 2010 are summarized below. And it should be pointed out that some of these scientific investigations have been successfully carried out as collaboration with researchers of many universities, research institutes and companies.

(i) Hydrogen isotope separation and removal technology

Tritium treatment is a main issue for fusion facilities. Isotope separation is one of key technologies for the fueling cycle and the tritium removal. To evaluate the hydrogen isotope retention in the fusion device is also important issue from viewpoint of fuel control and safety. Many researches and developments are carried out by the collaboration with many universities. These are multi-column pressure swing Adsorption System by Kyushu University, sensing using proton conducting oxide by IFRC in Kyushu University, feedback control of hydrogen pump using a high-temperature proton conductor by NIFS, water vapor adsorption by honeycomb-type Zeolites by NIFS, hydrogen isotope oxidation process by atmospheric pressure plasma by Nagano National College of Technology, and study on formation of metal-carbon mixed deposition layer and hydrogen isotope behavior by Kyushu University.

(ii) Tritium measurements

Since the radiated energy of β-ray from tritium is small, it needs a special technique to detect tritium. Non destructive and quantitative tritium measuring method in a plasma facing materials was developed by Pharm. Sci., Tohoku University. This method can detect β-ray from tritium separated from γ-ray from some γ-nuclides. Monitoring of tritiated gas is also a key technology for safety. Tritiated gas monitoring system using plastic scintillator and photon counter is developed in NIFS. This method has an advantage to reduce radioactive liquid organic waste.

(iii) Fueling

Fueling is a key issue for a fusion plant. To evaluate the required value for the tritium, taking account of the tritium consumption in a fusion reactor and initial inventory of a next reactor, is important. From this point of view, tritium balance in a DT fusion reactor was investigated by the collaboration with Kyushu University.

To enrich lithium-6 is necessary technology to establish the breeding of tritium by a blanket in a fusion reactor. Displacement chromatography using criptand resin for lithium isotope separation was investigated by experiments and numerical simulation by the collaboration with Nagoya University.

(iv) Safety in environment

In order to appraise the influence of tritium released from nuclear facilities to the environment, it is necessary to confirm the effect of tritium appearing overlapped on background tritium levels. To confirm the background tritium level in natural water samples at the NIFS, tritium concentrations and stable isotopes of oxygen and hydrogen in rain water, stream water and groundwater at the NIFS site were analyzed by the collaboration with Kyushu University. Dynamic compartment model has been developed by the other collaboration to predict the tritium behaviors in 'atmosphere – soil – river and groundwater flow' system at the site of NIFS. These are necessary to understand the behavior of tritium in terrestrial environment for estimation of dose by ingestion of tritium.

(Nishimura, K.)

List of Reports

1. "Experimental Study on Performance of Multi-column Pressure Swing Adsorption System for Hydrogen Isotope Separation", Kotoh, K. (Kyushu Univ.)
2. "A Study for Hydrogen Isotope Separation and Sensing using Proton Conducting Oxide", Matsumoto, H. (IFRC, Kyushu Univ.)
3. "A Feedback Control of Hydrogen Pump using a High-temperature Proton Conductor for Tritium Recovery System", Tanaka, M. (NIFS)
4. "Water Vapor Adsorption by Honeycomb-Type Zeolites for Tritium Removal System", Tanaka, M. (NIFS)
5. "Development of hydrogen isotope oxidation process by atmospheric pressure plasma", Ezumi, N. (Nagano National College of Tech.)
6. "Study on formation of metal-carbon mixed deposition layer and hydrogen isotope behavior", Katayama, K. (Kyushu Univ.)
7. "Separation method for measurement of radiation dose emitted from tritium in high gamma-ray radiation fields by using an imaging plate", Ohuchi- Yoshida, H. (Pharm. Sci., Tohoku Univ.)
8. "Development of Tritiated gas monitoring system using solid scintillation and air sampling system", Uda, T. (NIFS)
9. "Displacement chromatography using criptand resin for lithium isotope separation", Sugiyama, T. (Nagoya Univ.)
10. "Study on behavior of environmental tritium at Toki site", Sugihara, S. (RIC, Kyushu Univ.)
11. "Study on development of dynamic compartment model for estimation of environmental tritium behavior at the site of NIFS", Takahashi, T. (Kyoto Univ. Research Reactor Inst.)